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ABSTRACT

A fourth grade class (49 students) with a mean grade equivalent score of 2.8 on the Stanford Diagnostic Arithmetic Test was placed in a Sequential Computational Skills Math Program. The program consisted of 12 units (from basic addition and subtraction facts to fractions computation), and individual Ss' entry levels were determined by computation placement tests. The first and third phases of the study were experimental conditions, during which problems were completed using a computational approach; the second phase was the baseline condition, during which problems were completed according to a conceptual approach. From September to April, the number of Ss working on fourth grade material increased from 13 to 48. Additionally, rate of problems completed was significantly lower during the conceptual phase, the mean increase in math achievement was 2.5 years, and students' attitudes toward math noticeably improved. (LS)

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# THE EFFECTS OF A SEQUENTIAL COMPUTATIONAL SKILLS MATH PROGRAM ON AN UNDERACHIEVING FOURTH GRADE CLASS

by

Patricia Coleman, Kathleen Kaszuba and Mary Pierce

(At the time of this study, Patricia Coleman and Kathleen Kaszuba were fourth grade teachers at the Hinesburg Elementary School, Hinesburg, Vermont. Mary Pierce was a Consulting Teacher in the Chittenden South School District.)

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A fourth grade class with a mean grade equivalent score of 2.8 (with a range of 1.7 to 3.9) on the Stanford Diagnostic Arithmetic Test was placed in a Sequential Computational Skills Math Program. The first and third phases of this study were experimental conditions and the second phase was the baseline condition.

## Learners and Learning Environment

The program was initiated for 49 fourth grade students at the Hinesburg Elementary School in Hinesburg, Vermont. The children ranged in age from 8 to 9. Their math grade equivalents on the Stanford Diagnostic Arithmetic Test given in April, 1972 ranged from 1.7 to 3.9 with a mean of 2.8. The two students whose individual progress graphs are included in this study scored a 2.3 grade equivalent (Student C) and a 2.4 grade equivalent (Student D). Along with the low test scores, they had an aversion to math.

The classroom followed the open classroom design utilizing team teaching and an individualized instruction program. Students followed their own schedules for the morning.

## Minimum Instructional Objectives

At the completion of the math program, the student will be proficient to 80% accuracy in the computational skills of addition, subtraction, multiplication and division.

The math program involved the following units:

Grade Equivalent 1.0 - 3.0

1. Basic addition and subtraction facts
2. Addition without carrying: using 3 digit numbers
3. Addition with carrying: using 3 digit numbers
4. Subtraction without borrowing: using 3 digit numbers from 3 digit numbers
5. Subtraction with borrowing: using 4 digit numbers from 4 digit numbers

Grade Equivalent 4.0 - 5.0

6. Addition and subtraction: column and advanced subtraction
7. Multiplication facts
8. Multiplication using 1,2,3, and 4 digit numbers by a one digit number
9. Multiplication using 2,3, and 4 digit numbers by 2 and 3 digit numbers
10. Division facts
11. Division using 1 and 2 digit numbers into 2,3,4, and 5 digit numbers
12. Fractions computation

Measures

1. Entry Level. In September, a computation placement test based on the above units, was administered to each student. The level at which the student achieved less than 80% correct was the starting point for the student.

2. Daily Measurement. Daily measures of accuracy were kept for each child. Lessons in each unit consisted of three to five pages of problems which the student completed as described below. A mean daily percent correct score was computed ($\frac{\text{Total Correct}}{\text{Total per page}} \times 100$ equals percent correct per page; then average the percent correct of all pages) and plotted on a graph.

General Teaching/Learning Procedures

Students progressed through the units on a regular or accelerated schedule. Under the regular schedule the student began the unit with a lesson during which the teacher explained the unit, modeled examples on the board, asked each student to compute examples while verbalizing the steps involved, and assigned work for each student to complete. When the work was completed, students exchanged papers for immediate correction and recorded the number correct at the top of each page. For reliability the teacher scored the papers, recorded the number of problems correct per page. The students who had less than 80% correct were noted by the teacher as needing extra help.

Students with master level accuracy on daily lessons (80-100%) were placed on the accelerated schedule which allowed them to (1) do two or more day's work in one day, thereby allowing students to meet or exceed the minimum objective rate of completing units and (2) omit Unit VI if the evaluation for Unit V was between 90% and 100%

Under either schedule the student was evaluated when he completed the designated number of daily lessons for the unit. When he achieved at least 80% accuracy on the evaluation, he proceeded

to the next unit. Units dealing with basic facts (Units I, VII, X) were evaluated by means of a timed basic fact test.

To insure that each student received the maximum amount of attention and feedback, the teacher scheduled the math period as follows. First, unit evaluations were administered for each student who had completed the daily lessons for a unit. Second, the teacher corrected, recorded, and distributed the day's work to those groups achieving at least 80% correct on the previous day's work. Third, the teacher gave a lesson to those students who were beginning a unit or a new section of a unit. Fourth, the teacher spent the remainder of the math period working on a one-to-one basis with students who achieved less than 80% correct.

Computation Condition

During this condition, problems were completed using a computational approach, for example:

```
    1              11              11
(1) 234        (2) 235         (3) 235
   +496            +496            +496
   ---             ---             ---
     1              31             731
```

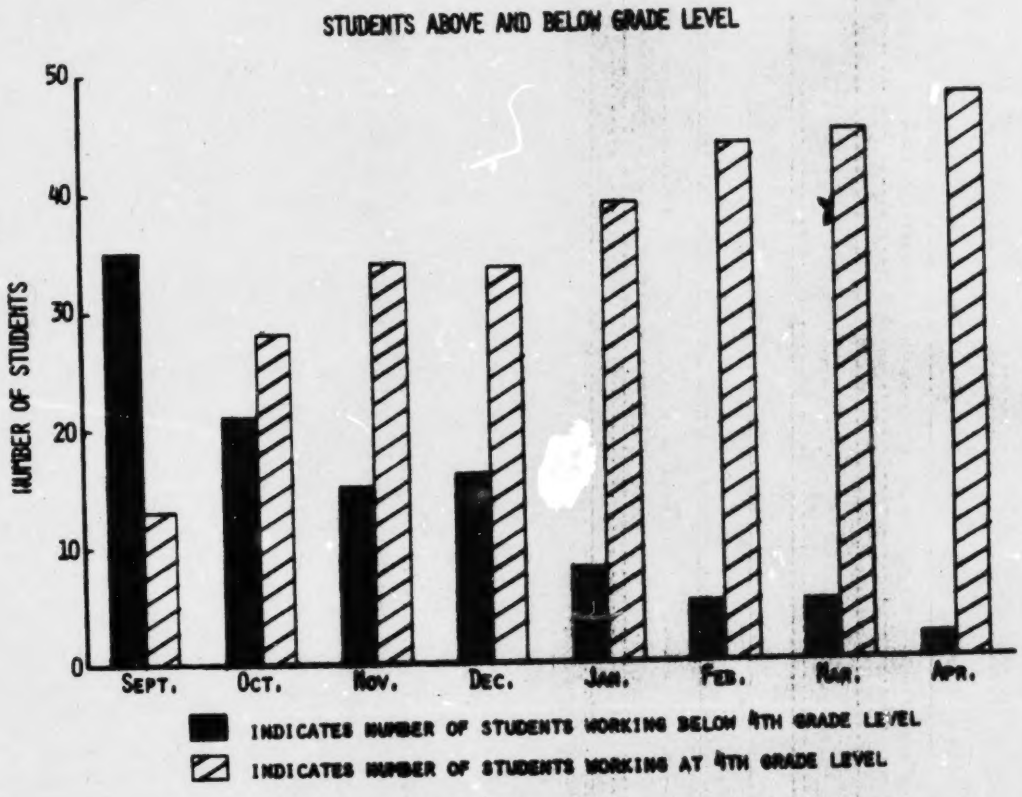
Concept Condition

During this condition the problems were completed according to a conceptual approach involving the concepts of place value and expanded notation.

For example, to add the same problem given upon the child followed these steps:

```
(1) 235=200+30+5
   +496=400+90+6
   ------------

(2) 235=200+30+5
   +496=400+90+6
   ------------
             11

(3) 235=200+30+5
   +496=400+90+6
   ------------
          120+11

(4) 235=200+30+5
   +496=400+90+6
   ------------
     600+120+11

(5) 235=200+30+5
   +496=400+90+6
   ------------
     600+120+10+1

(6) 235=200+30+5
   +496=400+90+6
   ------------
     600+100+20+10+1

(7) 235=200+30+5
   +496=400+90+6
   ------------
     600+20+1
     100+10+0

(8) 235=200+30+5
   +496=400+90+6
   ------------
     600+20+1
     100+10+0
   ------------
           1

(9) 235=200+30+5
   +496=400+90+6
   ------------
     600+20+1
     100+10+0
   ------------
          30+1

(10)235=200+30+5
   +496=400+90+6
   ------------
     600+20+1
    +100+10+0
   ------------
     700+30+1

(11) 235=200+30+5
   +496=400+90+6
   ------------
     700+30+1

(12) 235=200+30+5
   +496=400+90+6
   ------------
     700+30+1=731
```

FIGURE 1. The number of students working below 4th grade level and the number of students working at 4th grade level at the end of each month.

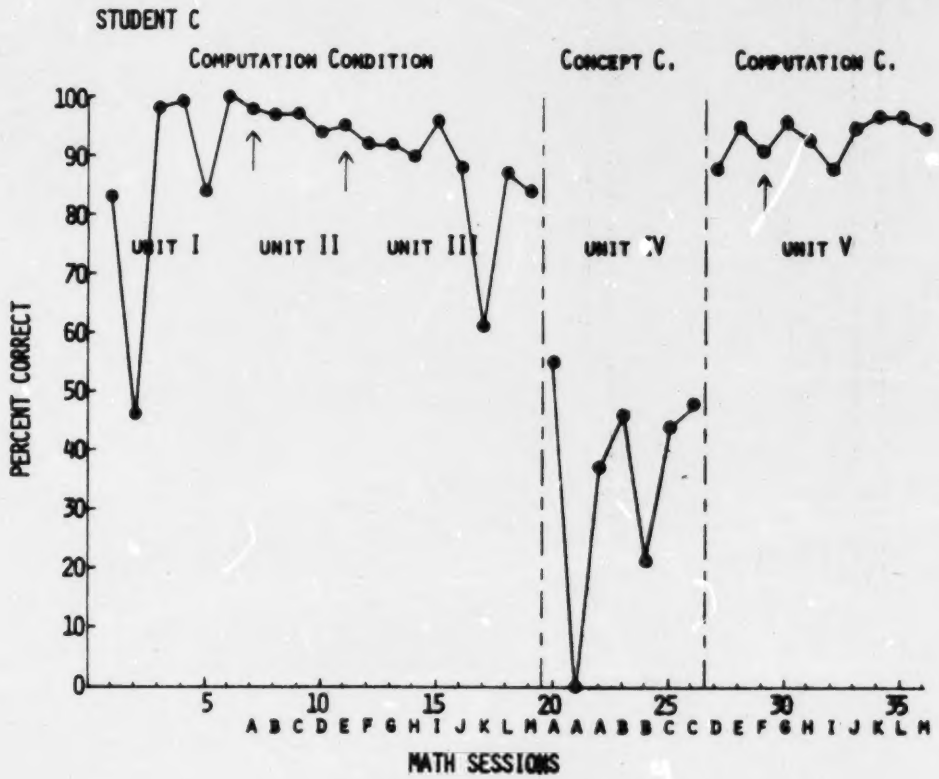



## Results

Figure 1 shows the number of students working on material below the fourth grade level and the number of students working on material at or above the fourth grade level at the end of each month, September through April. At the end of September, 13 students were working on fourth grade material; 35 students were working on material below the fourth grade level. By the end of April, 48 students were working on fourth grade material; two students were working on materials below the fourth grade level.

Daily measures of accuracy for the students are shown in Figures 2 and 3. Student C scored a grade equivalent of 2.3 at the beginning of the year. Specific entry level measures placed him in Unit I: Addition and Subtraction Facts. Since September he has progressed from Unit I to Unit VII. As shown from the graph in Figure 2, his average accuracy during the computation conditions was consistently higher (90% and 94% respectively) when compared with the concepts condition (36%).

FIGURE 2. Student C's daily percent correct in math assignments for Units I through V during computation conditions and concept condition. The letters below the sessions indicate individual assignments. Thus on days 20,21 and 22 Student C worked on the same assignment.



Student D (See Figure 3) scored a grade equivalent of 2.4 at the beginning of the year. Specific entry level measures placed him in Unit II: Addition Without Carrying. Since September, he has progressed from Unit II to Unit VI. As shown in Figure 3, his average accuracy during the computation conditions was consistently higher (94.5% and 93%, respectively) when compared with the concepts condition (23%).

During the concept condition the number of examples completed daily in the unit was below that unit's minimum objective. Student C's rate of problems completed during concept condition decreased to 57%. Student D's rate of problems completed decreased to 79%. On the return to the computational condition, the rate of problems completed by each student returned to the previous high rate and the percentage of problems correct also increased.

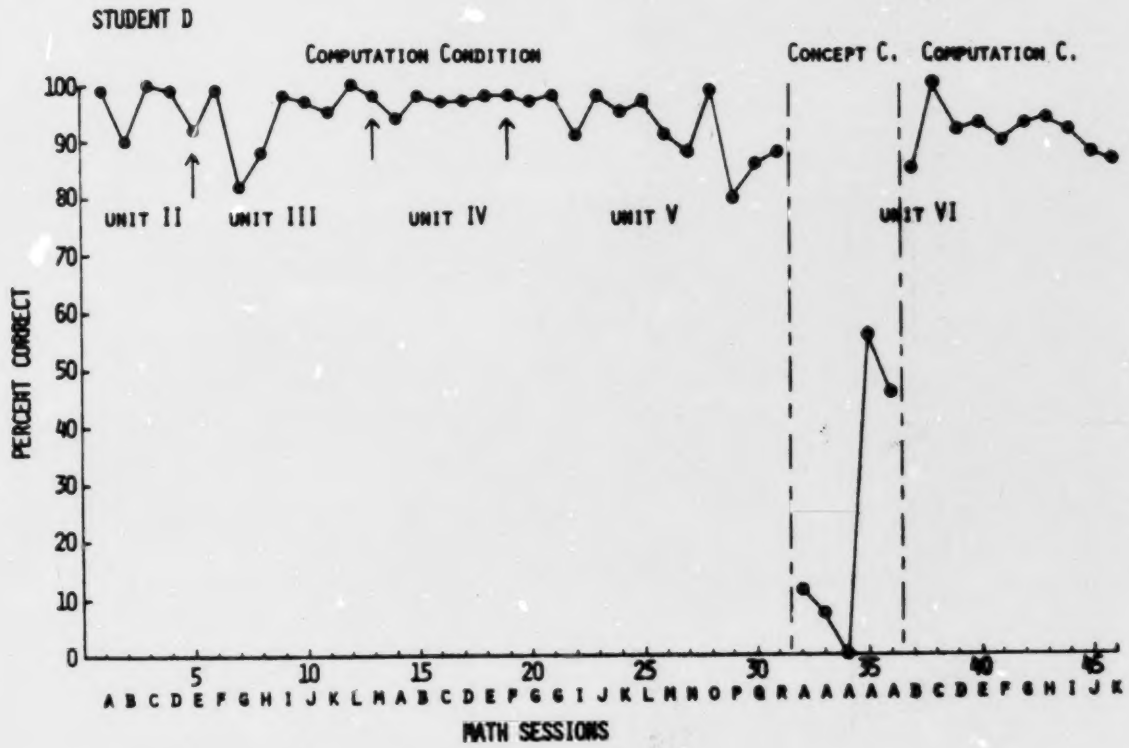



FIGURE 3. Student D's daily percent correct in math assignments for Units II through VI during computation conditions and concept conditio Thus on days 32, 33, 34, 35, 36 student D worked on the same assignmen

Figure 4 shows the minimum rate of acquiring fourth grade minimum math objectives at the end of four years of school. Students C and D entered school in September with skills at the first grade level. By the middle of May, students C and D had completed Unit I through Unit VII.

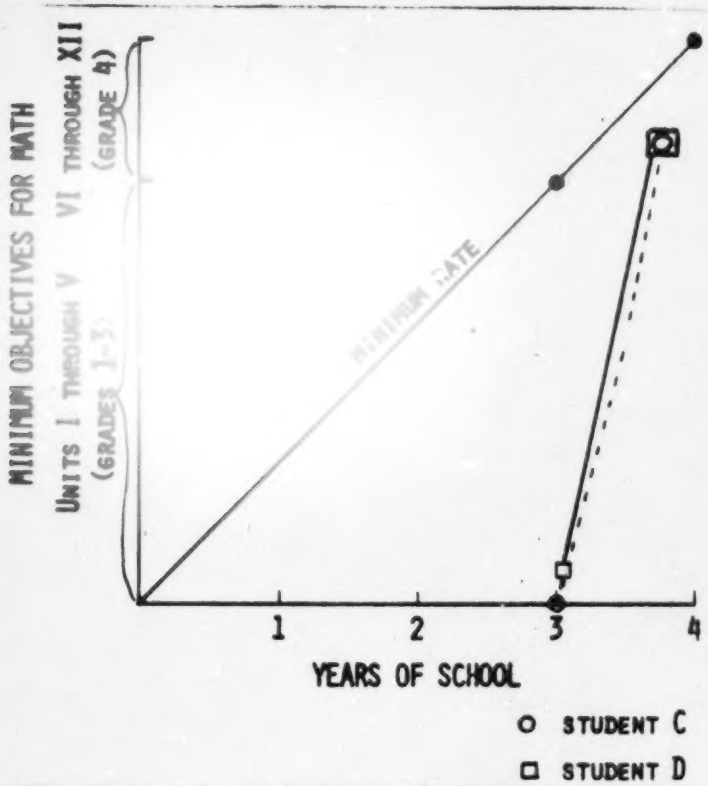



FIGURE 4. The rate of achieving minimum objectives for students C (O---O) and D (□—□) during the fourth year of math instruction. The solid diagonal line shows the minimum rate required to achieve mastery of the math objectives specified for the four years in school.

## Discussion

In addition to the dramatic "rise-fall-rise" pattern of accury concurrent with the introduction-removal-reintroduction of the computation condition, the student attitudes towards math changed. During the computation conditions, the students were eager for math period to begin. However, during the concept condition, there was marked lack of concern both for math and its completion. Although both students accurately responded to the concept approach, they became frustrated because it took longer to do. Thus, they could not move as quickly through the unit and they knew they were not progressing at a fast enough rate to complete the minimum objectives for that unit.

Students C and D were not the only students to show this pattern--the whole class did! The progress of the whole class has been so great that by April only two members of the class were working below fourth grade level compared to 35 children in September.

Furthermore, the Stanford Diagnostic Arithmetic Test readministered in April, 1973, indicated that the mean increase for the entire class was 2.5 years (with a range of 1.0 to 8.2) for computation skills and 1.9 years (with a range of .2 and 3.1) for concept skills. Thus, the use of the sequential computational skills math program appears to have been effective in increasing every student's rate of completion with a high degree of accuracy to meet the minimum objectives as well as increasing the children's achievement test scores.

Apparently the minimum objectives set by the teachers were appropriate for fourth grade students as evidenced by the latest achievement test scores. However, the use of achievement tests is limited in that school personnel usually test only once a year. With student progress monitored monthly on the minimum objectives graphs, the teachers were able to make more immediate educational decisions about particular teaching strategies for each student as well as the whole class. Their decision to continue the computational approach was based on a marked increase in performance demonstrated by each student. In addition, the students' enthusiasm contributed to the teachers' feelings of success in providing a successful and effective learning experience in math!